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Patent
Attorney's Docket No. 018420-001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

James E. TROUNSON

Application No.: 08/193,634

Filed: February 8, 1994

For: COMPUTER CONTROL SYSTEM
FOR GENERATING
GEOMETRIC DESIGNS

) Group Art Unit: 2306

) Examiner: T. Brown

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BRIEF FOR APPELLANT

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

This appeal is from the decision of the Primary Examiner dated April 21, 1994 (Paper No. 20), finally rejecting claims 1-3 and 18-19, which are reproduced as an Appendix to this brief.

A check covering the 140.00 requisite Government fee and two extra copies of this brief are being filed herewith.

The Commissioner is authorized to charge any fees that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800.

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I. Status of Claims

The present application contains 23 claims. Of these, claims 5, 6, 11-17 and 20-23 have been cancelled. Of the remaining pending claims, claims 4 and 7-10 have been allowed, and claims 1-3, 18 and 19, which form the basis for this appeal, stand finally rejected.

II. Status of Amendments

No amendments to the claims were filed after the final Office Action.

III. Summary of the Invention

The present invention is directed to apparatus for forming geometric shapes in materials, such as machine tools. Typically, to form complex geometric shapes, a tool and a workpiece are moved relative to one another along multiple axes of motion. For example, in one conventional type of machine tool to which the present invention is applicable, the workpiece is translated along each of two perpendicular axes, commonly denoted the x and y axes, and the machine tool is moved along a third, orthogonal axis, denoted the z axis. Through coordinated movement of the workpiece and the tool along these three axes, any desired geometric shape can be formed in the workpiece.

In a conventional machine tool control system, a large amount of processing power is required, and different parts of the manufacturing process are frequently carried out in different locations. Due to the distributed nature of various tasks to be performed, computer aided drawing and computer assisted manufacturing operations are carried out on one processor, whereas actual control of the machine is implemented with the use of several other processors. Typically, machine tool control systems allocate one processor per motor being controlled, with each motor providing the driving force along one axis of machine operation. In addition, another processor may be required to coordinate the activities of these motor controllers, and yet another processor may be used to handle user interface operations.

As discussed in greater detail in the background portion of the application, large, complex machine tool control systems of this type were limited in use to goods that were manufactured in large quantities. Because of the significant amount of programming required, it was not feasible to use these types of systems in environments where a

limited number of parts were to be machined. One of the primary objectives of the present invention is to simplify the machine tool control system to a point where its applicability to any job is feasible. In accordance with this objective, the present invention provides a control system in which a central computational resource is shared among all motors in the system. In particular, a single microprocessor is used for all system functions. With this approach, all of the motors are controlled in a coordinated and integrated fashion by a central computational resource, and no active components are dedicated specifically to a single motor. In addition to motor control, the single processor carries out all aspects of a CAD/CAM operation. Thus, in addition to controlling the various motors which drive the tool and/or workpiece along respective axes of motion, the microprocessor also serves as the host by which information describing a desired shape is entered into the system and, in response to this information, it produces data that describes a sequence of operations to be performed by the motors, to generate a desired shape within a formable material.

Referring to the embodiment of the invention illustrated in Figure 1, the control system includes a central processing unit 12 that communicates with an interface card 14 having ports which transfer data between the CPU 12 and external power boards 18. One power board is associated with each axis that is under the control of the servo system. Each power board is connected to a motor 20 which provides the driving force for the axis, and an encoder 22 which provides feedback information regarding the position and/or velocity of the motor.

The CPU 12 is the only "active component" in the system. As set forth on page 7, lines 16-20, in the context of the present invention, the term "active" denotes a component or circuit which receives feedback information, processes it and carries out the operations necessary to complete a feedback loop. Since the processor 12 handles all active functions, the need for master-slave processors, analog servo-loops, interprocessor communications and data format translations is eliminated.

The architecture of the software that controls the microprocessor 12 is illustrated in Figure 2. Basically, as described on page 10 of the application, this software performs 4 fundamental tasks, namely low-level servo-loop control 28, user input monitoring 29, tool path calculations 30 and user interface functions 31. The three highest priority tasks 28, 29 and 30 are periodically implemented through hardware-generated interrupt

requests, whereas the fourth task 31 is a foreground task which operates whenever no hardware interrupts are pending or active. As a result of this architecture, multiple operations can be carried out simultaneously. Thus, while extended cutting operations are being implemented on a machine tool under the control of the system, other parts can be concurrently designed or other operations on the part being machine can be concurrently programmed.

IV. The Issues

Two issues are presented for review on this appeal:

1. Are claims 1-3, 18 and 19 anticipated by the Hyatt patent, U.S. Patent No. 4,829,419?
2. Are claims 1-3, 18 and 19 unpatentable over the Daggett patent, (U.S. Patent No. 4,786,847) in view of the Hyatt patent?

V. Grouping of Claims

Appellant does not consider all claims to stand or fall together with respect to each of the two grounds of rejection. In particular, even if independent claim 1 is considered not to be patentable over the cited prior art, dependent claims 3, 18 and 19 recite additional subject matter which provides a separate basis for their patentability.

Arguments supporting the separate patentability of these claims are set forth in the following section of this brief.

VI. Argument

- A. The Hyatt patent does not disclose the use of a single active processor for controlling each of the functions recited in claim 1, and therefore does not anticipate claims 1-3, 18 and 19

The final rejection of the claims states that claims 1-3, 18 and 19 are anticipated by the Hyatt patent, with particular reference to Figure 1 and column 6 thereof.

Referring to Figure 1, the Hyatt patent is directed to a machine tool control system which includes a data processor 12. In addition to the data processor, the system includes three servos, 20, 21 and 22, "for independent tool axis control" (column 5, lines 47-58). The data processor 12 itself performs only a portion of the overall control of the movement along each of the three axes. In particular, with reference to the description of Figure 3,

the data processor sends each servo "a digital position signal 71 which indicates a commanded servo position" (column 15, lines 10-12). In response to receipt of this position signal, the individual servos carry out the remainder of the control function. In particular, as shown in Figure 3, the servos include comparator circuits 86 which produce square waves signals 87 that indicate the difference between the commanded position and the actual position, as detected by a resolver 78. See, for example, column 15, lines 29-33. This square wave signal is sent to a digital-to-amplitude converter within the servo, which produces an error signal that is used in controlling the servo motor 99.

Unlike the subject matter recited in the rejected claims, the control system disclosed in the Hyatt patent does not use a single active processor to perform each of the functions of controlling a data defining means, controlling a data converting means, receiving feedback information from each of the feedback devices, and controlling the operation of each of the motors to provide coordinated relative movement. Rather, these various functions are split among different active systems. It is the individual servos, rather than the data processor 12 of the Hyatt system, which perform the functions of receiving feedback information and controlling the operation of each of the motors. These servos are active processing devices in addition to the data processor 12. Thus, the Hyatt patent cannot be interpreted to anticipate the subject matter of claims 1-3, 18 and 19.

The final rejection of the claims takes issue with Appellants' contention that the Hyatt system relies upon more than one active processor to perform all of the claimed functions. In particular, the final action states "there is no active processor in figure 3, thus, the only active processor in Hyatt's system is data processor 12." This statement is apparently based on the fact that the Hyatt patent does not specifically use the word "processor" to identify any of the elements depicted in Figure 3.

The mere fact that the Hyatt patent does not use the term active processor, or the like, in describing the components of Figure 3 does not mean that the circuit of that figure does not include an active processor. The term "active processor" must be interpreted in the context within which it is used in the claims. In this regard, reference to the specification is appropriate, to determine the meaning given that term by Appellant. Referring to page 7, lines 16-20, the specification states:

In the context of the present invention, the term "active" denotes a component or circuit which receives feedback information, processes it and carries out the operations necessary to complete a feedback loop.

Viewed in this context, it can be seen that the data processor 12 of the Hyatt machine control system is not the only active processor. In particular, it is not the only device within that system to perform the functions quoted above. Insofar as the feedback loop for the control of the motors is concerned, the circuitry which performs the operations of receiving feedback information, processing it and completing the feedback loop is the individual servo circuit of Figure 3. In particular, the comparator 86 and digital tachometer 92 receive the feedback information (the position feedback signal 83) for one axis, process it (to produce a position different signal 87 and a velocity duration signal 94), and carry out the operations necessary to complete the feedback loop for that axis (through the combination of the signals which is applied to the servo motor 99). These functions are clearly performed outside of the data processor 12. Thus, the servo control circuit of Figure 3 is an active processor as well, as that term is employed in the context of the present invention.

In contrast to the structure disclosed in the Hyatt patent, claim 1 recites that the single active processor performs the functions of (1) controlling the data defining means and the data converting means, (2) receiving feedback information from each of the feedback devices, and (3) controlling the operation of each of the motors. The data processor 12 of the Hyatt patent does not perform all of these functions. It does not receive feedback information from each of the feedback devices, i.e. the resolvers 78. In addition, the actual control of the operation of each of the motors is carried out individually within the respective servo circuits 20, 21 and 22, rather than the data processor 12. Nor does it carry out the functions of controlling the data defining means, e.g. user-entered design information, or the data converting means, which converts the user-entered information into machine control information.

In summary, the Hyatt patent does not disclose the concept of using a single active processor to provide coordinated control of movement along multiple axes, and therefore does not anticipate the subject matter of claims 1-3, 18 and 19.

B. The Daggett patent does not disclose the use of a single active processor to control a multi-axis machine, and therefore does not suggest the subject matter of claims 1-3, 18 and 19, whether considered alone or in combination with the Hyatt patent

Claims 1-3, 18 and 19 were rejected under 35 U.S.C. §103 as being unpatentable over the Daggett patent in view of the Hyatt patent. The rejection states that the Daggett patent discloses a digital position and velocity feedback system for a multi-axes machine. The rejection goes on to state that the disclosure of the Daggett patent differs from the subject matter of claims 1-3, 18 and 19 "by not using a single active processor to control the multi-axes machine." To compensate for this difference between the claimed subject matter and the disclosure of the Daggett patent, the rejection relies upon the Hyatt patent as disclosing an architecture wherein a single active processor is allegedly used "for direct interaction with a machine to enhance communication and to reduce special purpose interface circuitry." The rejection concludes that it would be obvious to replace the multiprocessor control system of the Daggett patent with a single active processor "as disclosed by Hyatt."

The rejection explicitly acknowledges that one of the main distinctive features of the present invention, i.e. the use of a single active processor to control all of the functions recited in claim 1, is not suggested by the Daggett patent. Rather, it relies upon the Hyatt patent as allegedly disclosing such a concept. In fact, however, the Hyatt patent does not contain any such teaching, as pointed out in section 6.a. of this brief.

Thus, since the Hyatt patent does not disclose the concept of using a single active processor to perform all of the functions recited in claim 1, any reasonable combination of its teachings with those of the Daggett patent cannot result in a suggestion of such a concept. Accordingly, the subject matter of the rejected claims is not rendered unpatentable by the Daggett patent, when viewed in light of the disclosure of the Hyatt patent.

C. The subject matter of the dependent claims is not disclosed in the Hyatt and Daggett patents

1. Claim 3

Claim 3 recites that the active processor produces coordinated relative movement of the tool by controlling the motors in a cyclic manner, where each cycle comprises a

sequential reading of feedback information and the generation of a motor control signal for each of the axes being controlled. As noted previously, the data processor 12 of the Hyatt patent does not read feedback information indicative of the position and/or velocity of the tool along an associated axis. Rather, this information is received and processed in the servo controllers. Furthermore, the rejection does not point out where the Hyatt patent discloses the concept of producing coordinated relative movement of the tool by controlling the motors in a cyclic manner, in the fashion recited in claim 3. Accordingly, the subject matter of this claim is neither anticipated nor otherwise suggested by the Hyatt patent.

2. Claim 18.

Claim 18 depends from claim 3 and recites that the data representative of geometric shapes to be formed in a material comprises a sequence of operations which define the geometric shape. The claim also recites that the data converting means processes this sequence of operations to produce a table that describes the movement of the tool along each axis, relative to the workpiece, for each cycle of operation.

As noted above, the final rejection has not identified where the Hyatt patent can be deemed to disclose a cyclic type of operation as recited in claim 3. Furthermore, it does not identify where the Hyatt patent can be deemed to disclose the concept of a data converting means which processes a sequence of operations to produce a table that describes the movement of the tool along each axis for each cycle of operation. For this additional reason, therefore, claim 18 is neither anticipated nor otherwise suggested by the disclosure of the Hyatt patent.

3. Claim 19.

Claim 19 recites that the data defining means includes a user interface by means of which a user communicates with the single active processor to define and/or modify geometric shapes. The claim also recites that the active processor stores data defining a geometric shape in response to communications received from a user through the user interface.

The Hyatt patent does not disclose this subject matter. Particularly, rather than a user interface by means of which the user communicates with the processor to define

and/or modify geometric shapes, the system of the Hyatt patent includes a tape reader 16 which receives part program data. In other words, to the extent that a user is permitted to define geometric shapes in the system of the Hyatt patent, that definition takes place somewhere apart from the data processor 12. The user input is then processed to produce a punched tape, which is subsequently fed to the data processor 12. In response to data input from the tape, the data processor 12 sends commands to the various servos 20, 21 and 22 to control the motors. Thus, it can be seen that the system of the Hyatt does not include a user interface by means of which a user communicates with the data processor 12 to define and/or modify geometric shapes, nor does the processor 12 store data defining the shapes in response to communications received from a user over such an interface.

VII. Conclusion

As discussed above, the Hyatt patent does not disclose the concept of using a single active processor to carry out all of the various functions associated with defining a shape to be cut into a material and controlling a multiaxis machine in a coordinated manner to form such a shape in the material. Furthermore, it does not disclose the additional features of the invention recited in the dependent claims. The rejections of the claims are not properly founded in the statute, and should therefore be reversed.

Respectfully submitted,

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APPENDIX

The Appealed Claims

1. A system for controlling the formation of geometric shapes in materials by moving a tool relative to a workpiece along multiple axes of movement, comprising:
 - means defining data representative of geometric shapes to be cut or otherwise formed in materials;
 - means for converting said data into a description of a path to be followed by the tool and storing said description;
 - a plurality of motors respectively associated with said multiple axes, each of said motors providing relative movement between the tool and the workpiece along an associated one of said axes;
 - a plurality of feedback devices respectively associated with said plurality of motors for providing feedback information indicative of at least one of the actual position and velocity of the tool along an associated axis; and
 - a single active processor for controlling said data defining means and said data converting means, for receiving feedback information from each of said feedback devices, and for controlling the operation of each of said motors to provide coordinated relative movement between the tool and the workpiece along each of said multiple axes in accordance with said stored path description.

2. The servo system of claim 1 wherein said single active processor comprises a single microprocessor.

3. The servo system of claim 1 wherein said active processor produces said coordinated relative movement of the tool by controlling said motors in a cyclic manner, wherein each cycle comprises a sequential reading of feedback information and generation of a motor control signal for each of the axes being controlled.

18. The system of claim 3 wherein said data comprises a sequence of operations which define said geometric shape, and said data converting means processes said sequence of operations to produce a table that describes the movement of the tool along each axis, relative to the workpiece, for each cycle of operation.

19. The system of claim 1 wherein said data defining means includes a user interface by means of which a user communicates with said single active processor to define and/or modify geometric shapes, and wherein said single active processor stores said data in response to communications received from a user through said user interface.